

Private Provision of a Public Good

Social Capital and Solid Waste Management in Dhaka, Bangladesh

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Some neighborhoods in Dhaka have successfully organized an alternative to municipal trash collection and some have not. What determines whether a neighborhood or community is likely to undertake collective action?



Summary findings

Pargal, Gilligan, and Huq try to identify the determinants of private, community-based provision of a public good—in this case, trash collection. Using survey data for Dhaka, Bangladesh, where some neighborhoods have successfully organized an alternative to the municipal trash collection service, they examine why some communities or neighborhoods display such initiative while others do not.

Their results show that social capital—trust, reciprocity, and sharing—is an important determinant of whether alternative systems arise in Dhaka. More generally, public-private partnerships or self-help schemes appear more likely to succeed in neighborhoods high in social capital.

Other measures of homogeneity of interests are also important. So, interestingly, is the nature of associational activity.

Finally, education levels are strongly and robustly associated with the existence of collective action for trash disposal.

How can policymakers encourage such activity? The process through which community residents start cooperating for the common good is a function of the strength of their relationships. Government attempts to initiate the process are therefore unlikely to boost social capital directly, but by lowering information and transaction costs they may facilitate a virtuous cycle of successful cooperation and strengthening social ties.

This paper—a product of the Private Sector Cluster, Latin America and the Caribbean Region—is part of a larger effort in the region to examine the determinants of private provision of public goods. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Sheoli Pargal, room I5-039, telephone 202-458-1951, fax 202-522-2106, email address spargal@worldbank.org. Policy Research Working Papers are also posted on the Web at www.worldbank.org/research/workingpapers. Daniel Gilligan may be contacted at gilligan@arec.umd.edu. August 2000. (32 pages)

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**PRIVATE PROVISION OF A PUBLIC GOOD:
SOCIAL CAPITAL AND SOLID WASTE MANAGEMENT IN DHAKA, BANGLADESH***

by

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* The World Bank, the University of Maryland, and the Development Policy Group (Bangladesh), respectively. Financial support for this work was provided by the World Bank's Social Capital Initiative (SCI), funded by the Danish government. We thank Thierry van Bastelaer and Christiaan Grootaert of the SCI for their support and comments and thank Jyotsna Jalan, Lant Pritchett, Hanan Jacoby and Anna Wetterberg for helpful comments and suggestions.

1. Introduction

This paper seeks to identify the determinants of the private, community-based provision of a public good, in this case, trash collection. The *community* aspect is vitally important here since trash collection involves positive externalities leading to limited incentives for individual action. Also, trash collection is an activity in which individual action does not have much impact, so collective action is warranted. Why are some communities better able to organize themselves for the collective good than others? Given the same impetus, what particular characteristics of the community lead to activism in some neighborhoods and none in others?

The context for this work is the fact that households in some neighborhoods of Dhaka, Bangladesh, have organized themselves to arrange for private collection of trash. The garbage collection system in Dhaka involves municipal pick-up from large dumpsters placed in central areas, with municipal workers responsible for collecting trash from smaller dumpsters located in alleys and side streets and transporting it to the main dumpsters. However, municipal employees are unreliable and frequently fail to collect the trash on a regular basis. In response, some communities have hired private contractors to undertake local trash collection funded by voluntary contributions from community members. Since other, apparently similar, neighborhoods have not managed to successfully organize an alternative to the municipal service, a natural question is why some communities or neighborhoods display such initiative while others do not.

We conjecture that “social capital” is a critical determinant of such collective action, where we equate social capital with community cohesiveness or the resources that exist in social relationships. The cohesiveness of the community is, in turn, a function of factors like customary or traditional interactions and institutions, a common heritage, ethnic or religious background, etc. Using data obtained from a survey of neighborhoods in Dhaka, we examine the importance of these potential determinants of social capital in the establishment of voluntary solid waste management (VSWM) systems as described above. We view the creation of these systems as a direct benefit of collective action, which is a function of the social capital in the neighborhood.

If social capital has economic value, then it should be particularly effective in supporting cooperation to overcome the free-rider problem in the private provision of public goods. However, the role of social capital in this setting has not been subjected to much rigorous quantitative analysis. This study is an effort in that direction. In addition, we compare the role of social capital in explaining private provision of public goods to that of more traditional explanatory variables such as education, group size, and income.

The empirical approach employed accounts for a number of issues brought on by the underlying process of cooperation for public good provision and by the data itself. We use measures of trust and of the strength of norms of reciprocity and sharing among neighborhood residents as proxies for social capital in a probit regression explaining the probability that a neighborhood has created a VSWM system. However, the

process of organizing the community to support the trash disposal scheme may, in itself, contribute to our indicators of social capital. In order to account for this source of simultaneity, we estimate a system of equations with endogenous variables including the measures of social capital and a discrete indicator of VSWM system presence. We implement this simultaneous equations system with both continuous and discrete endogenous variables following the approach of Rivers and Vuong (1988).¹ Consistent estimation also requires that we account for the sampling procedure used in collecting the data. Because there were only 55 neighborhoods in Dhaka with a VSWM system in place at the time of the survey, neighborhoods were selected in a *choice based sample* stratified on the presence of a VSWM system to increase the number of VSWM systems in our sample and improve the precision of the parameter estimates. In order to remove the inconsistency caused by this sampling technique, we reweight the observations in the VSWM probit using the techniques of Manski and Lerman (1977).

Our results show that social capital is, indeed, an important determinant of whether VSWM systems arise in Dhaka. The effects of norms of reciprocity and sharing on the probability that a VSWM system is created are relatively large and significant, while the role of trust is not identified as a significant factor. Other measures of homogeneity of interests are also important, and, interestingly, so is the *nature* of associational activity. Finally, education levels are strongly and robustly associated with the existence of collective action for trash disposal.

The structure of this paper is as follows. In section 2 we briefly describe the literature on social capital relevant to this study. We describe our modeling and empirical estimation strategy in sections 3 and 4, and our survey and data in sections 5 and 6. We present our empirical results and discuss their implications in section 7. Section 8 concludes.

2. Social capital

The term 'social capital' has been applied to a variety of ideas that generally concern economic returns from networks of social relationships. While there has been limited work in economics on providing a theoretical context for social capital, there is a growing empirical literature that identifies considerable economic returns to networks of social relationships, to trust and norms of reciprocity, and to institutions that foster civic engagement.

¹ This approach was also chosen over other available methods because it has been shown to provide more efficient estimation in small samples. Our sample consists of 65 neighborhoods from Dhaka.

Social capital first gained popularity and analytical teeth from James S. Coleman's works (1988, 1990). Citing Loury's (1977) definition of social capital as "the set of resources that inhere in family relations and in community social organization..." (1990, p. 300), Coleman sees social capital as the "social relationships which come into existence when individuals attempt to make best use of their individual resources" (1990, p. 300).

Like other forms of capital, social capital is productive, making possible the achievement of certain ends that would not be attainable in its absence. Like physical capital and human capital, social capital is not completely fungible, but is fungible with respect to specific activities.... Unlike other forms of capital, social capital inheres in the structure of relations between persons and among persons. It is lodged neither in individuals nor in physical implements of production. (1990, p. 302)

While Coleman stresses social capital as resources that accrue to individuals, Putnam (1993) popularized a definition of social capital as resources that can characterize societies: "Social capital here refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions" (1993, p. 167). Putnam is concerned not only with the role of social capital in economic development, but also with its role in forming democratic societies. Thus, the strength of social capital within a society is represented in the intensity of 'civic engagement' found there. Putnam argued that the quantity and intensity of individual membership in social and professional associations is a good indicator of social capital. This indicator has been used by many researchers to test the benefits of social capital (see Narayan and Pritchett (1999), Knack and Keefer (1997), Helliwell and Putnam (1995), Meyerson (1994), and Boxman, De Graaf and Flap (1991), for example).

Social networks can be characterized as primarily 'horizontal', in which individuals share relatively equal status and power, or primarily 'vertical,' with asymmetric relationships based on hierarchy and dependence. Putnam argues that horizontal networks such as "neighborhood associations, choral societies, cooperatives, sports clubs, mass-based parties, and the like" (1993, p. 173) are the building blocks of 'networks of civic engagement.' These networks are "an essential form of social capital: the denser such networks in a community, the more likely that its citizens will be able to cooperate for mutual benefit" (1993, p. 173). We empirically test the importance of these networks in fostering cooperation for public good provision below.² In addition, Putnam notes that trust and reciprocity to sustain civic networks (i.e.,

² For Coleman, social capital, though not embodied in individuals, is a capital asset whose benefits are best measured at the individual level. However, Putnam treats the aggregation of social networks as representing the social capital of a society. In a critique of Putnam, Harriss and De Renzio (1997) question whether this type of 'scaling up' is consistent with the idea of the strength of social ties as a form of capital. In particular, because social organization can also be used to exclude others from economic benefits or for rent-seeking as noted by Olson (1982), the aggregate gain from summing individuals' benefits from social interaction may be ambiguous. While we find Coleman's articulation of social capital more consistent with economic theories of human capital development, for example, we refer in our

social capital) are self-reinforcing because as these networks become more dense the costs of opportunistic or selfish behavior increase.³ This implies endogeneity in regressions that attempt to explain a product of social capital with some measure of trust or reciprocity, for instance.

There are several mechanisms through which social capital might affect economic outcomes. Repeated interaction by economic actors through social networks strengthens trust and lowers information asymmetries, thus lowering transaction costs and increasing the enforceability of contracts. Two of the most thorough empirical investigations of the economic benefits of social capital look directly at the role of social capital in income generation, one at the household level and the other in cross-country comparisons. Following Putnam, Narayan and Pritchett (1999) measure social capital using involvement in civic and professional associations and show that at both the household and village level, social capital is a significant determinant of income for a sample of households in Tanzania.⁴ In order to remove the potential endogeneity of social capital due to simultaneous effects of income on associational activity (which would result if social capital were a consumption good), the authors instrument for social capital using indicators of trust from survey questions.⁵

In a cross-country empirical study, Knack and Keefer (1997) show that social capital matters for economic growth, using indicators of trust and of civic cooperation as direct measures of social capital. They deal with the potential endogeneity of social capital in their regressions of economic performance by using performance data that is subsequent to the measures of trust and civic cooperation. Testing the importance of Putnam's horizontal networks by measuring the effect of associational activity on trust, civic cooperation, and economic growth, they find no relationship between associational life and these measures.

Studies on the role of social capital in fostering public good provision are rare. The most closely related literature concerns the conditions for collective action in management of common property resources (see, for example, Ostrom (1990, 1996), Baland and Platteau (1996, 1997), White and Runge (1994), and De Janvry, McCarthy, and Sadoulet (1998)). A more relevant exception is Beall (1996) where case studies are presented of cooperative action for the provision of solid waste management (SWM). In Bangalore, India, Beall found free riding and caste considerations undermined the effort of horizontal associations of NGOs to organize neighbourhood based SWM. In Faisalabad, Pakistan, Beall found that poorer communities were

analysis to neighborhood social capital. By this we mean no more than the average level of trust or strength of norms of reciprocity benefitting individuals in a given neighborhood.

³ A number of studies—both theoretical and empirical—consider the economic benefits of trust (Fukuyama (1995), Narayan and Pritchett (1999), Knack and Keefer (1997)), norms of reciprocity (Sugden (1984, 1986)), culture (Harrison (1992), Greif (1994)), and ethnicity (Borjas (1992, 1995)) either as (sometimes implicit) determinants of or proxies for social capital.

⁴ Household social capital is measured by the number of associations to which respondents belong, with membership weighted by the quality of the association in raising social capital. The latter is measured by characteristics of the associations and the respondents' assessment of the trust and social cohesion in the group (including kin heterogeneity, income heterogeneity, group functioning, group decision making, and voluntary membership). Village-level social capital is defined as the product of the average number of groups per household times the average group characteristics.

sometimes able to gain access to public services by offering their neighborhoods as vote banks, guaranteeing support at the polls in exchange for electricity, sewerage and the like. In Pakistan, it was vertical rather than horizontal networks between neighborhood leaders and politicians that enabled the provision of public goods by the government.⁶

3. Modeling the development of VSWM systems

We explain the role of social capital in the formation of a VSWM system using a threshold model of public good provision following Black, Levi, and de Meza (1993). We assume that initiators propose the creation of a VSWM system to neighborhood residents for their consideration. The initiators will form the neighborhood VSWM system only if a large enough number of households decides to participate.⁷

Individual households undertake a cost-benefit analysis to decide whether to join the proposed system, recognizing the impact of their decision on the probability of the system coming into being. Our fieldwork surrounding data collection indicates that this analytical context for VSWM system formation is a good representation of the actual process occurring in the neighborhoods of Dhaka.

Let N be the number of households in the neighborhood, and n the threshold, i.e., the number of participating households necessary for VSWM system formation. Let the cost per household of participation, c , be declining in k , the level of neighborhood social capital, ($c'(k) < 0$) due to increased ease of coordination and easier flow of knowledge as social capital increases. The private benefits to household i of trash disposal, b_i , are augmented by the household's social capital, k_i , so that total private benefits from joining the VSWM system are $B(k_i, b_i)$.⁸ The effect of household social capital on total private benefits from joining the VSWM system depends on the nature of social norms in the neighborhood. If norms of reciprocity are strong, we expect that households with stronger ties in the community (higher k_i) earn greater (net) rewards for their cooperation by reinforcing their standing and from the act of participating in a community initiative ($B_1(k_i, b_i) > 0$). We can assume that these benefits are additive in k_i and b_i , so that if, for example, reciprocity norms are well developed households with strong ties in the neighborhood but low concern for public cleanliness may earn as much direct benefit from joining the system as a household of

⁵ This is consistent with Fukuyama's (1995) notion that trust, in part, determines the effectiveness of social capital.

⁶ An important insight of Beall's work is that, in the rush to decentralize government, many have turned to social capital as a potential mechanism for the private provision of public goods. Attempts to tack additional services, such as security details or health committees, onto existing local cooperative efforts may fail because they ignore the characteristics of the problem that originally caused people to organize.

⁷ In order for the proposed project to be viable, a minimum number of households is required in order to cover fixed costs associated with operating the system (such as the purchase of a cart to transport the trash).

⁸ Here, household social capital, k_i , is restricted to the social capital that exists in the household's relationships with other households in its neighborhood, whereas neighborhood social capital, k , is a measure of the average social capital of all households in the neighborhood.

environmentally conscious members that does not have close neighborhood ties. We also assume that $B(k_i, b_i) < c(k)$ for all $i = 1, \dots, N$ so that no household is willing to act alone.

In addition, the benefits of trash removal as a public good are assumed to be linear in the number of households that enroll in the system, so that a household receives an additional benefit equal to b_i for each other household that joins up. Thus, if r other households join, the i th household's benefits are augmented by $b_i r$. The probability that r other households will join the system is given by $\Pr(r | N-1, k)$, which is a function of the number of other households in the neighborhood, $N-1$, and k , the level of neighborhood social capital. The VSWM system will only come into being if $r \geq n$.⁹

Households are assumed to act non-strategically, taking the decisions of other households as given. The i th household will commit to participating if the expected benefits from taking part exceed the expected gains from free-riding if the VSWM system is formed:

$$(1) \quad b_i \sum_{r=n-1}^{N-1} r \Pr(r | N-1, k) + [B(k_i, b_i) - c(k)] \sum_{r=n-1}^{N-1} \Pr(r | N-1, k) > b_i \sum_{r=n}^{N-1} r \Pr(r | N-1, k).$$

The first term above represents the expected benefits to the i th household of at least $n-1$ other households agreeing to join the VSWM system when the i th household joins, so that the system is formed and trash is collected (the public good element). The second term represents the direct expected net benefits to the i th household of its own contribution. The term to the right of the inequality is the expected (non-excludable) benefits to the i th household assuming that it decides not to join but the VSWM system is formed anyway.

Rewriting the participation constraint clarifies the tradeoff between free-riding and participation faced by each household in its decision to join. The i th household will agree to join if the expected public-good benefit from being the critical n th vote exceeds the expected net cost of agreeing to join before it is known if the system will form.¹⁰

$$(2) \quad b_i (n-1) \Pr(n-1 | N-1, k) > [c(k) - B(k_i, b_i)] \sum_{r=n-1}^{N-1} \Pr(r | N-1, k).$$

The probability of a VSWM system being formed in neighborhood j is the probability that at least n households agree to participate. Let \tilde{r} be the number of households that agree to join. Defining $y_j = 1$ if a VSWM system is formed in neighborhood j , and $y_j = 0$ otherwise,

$$(3) \quad \Pr(y_j = 1) = \Pr(\tilde{r} \geq n) = \sum_{\tilde{r}=n}^N \Pr(\tilde{r} | N, p_1(k_1), \dots, p_N(k_N)),$$

⁹ As households do not observe the threshold for the existence of a VSWM system, we assume it is exogenous.

¹⁰ Many of the VSWM systems in Dhaka provide two services, collection of trash from household bins and removal from centralized neighborhood bins. The latter service is clearly a neighborhood public good. Although trash collection at the household is a private good, when the trash is not collected regularly it often ends up in public areas such as streets and vacant lots. The model developed here focuses on the public good component of these services.

where $p_i(k_i)$ is the probability of the i th household joining the VSWM system, i.e., the probability that the participation constraint in (1) is satisfied for the i th household:

$$(4) \quad p_i(k_i) = \Pr\left(b_i \sum_{r=n-1}^{N-1} r \Pr(r | N-1, k) + [B(k_i, b_i) - c(k)] \sum_{r=n-1}^{N-1} \Pr(r | N-1, k) > b_i \sum_{r=n}^{N-1} r \Pr(r | N-1, k)\right)$$

This suggests a probit model of neighborhood cooperation in which the latent variable, y_j^* , measures the intensity of cooperation for public good provision in the j th neighborhood. In the next section, we describe the empirical implementation of this model.

Obviously household benefits from the VSWM systems are not observed and the costs are known only in neighborhoods where the system exists. However, under our assumption of non-strategic behavior in which household j does not take account of the decision process of household i , an increase in $p_i(k_i)$ for an arbitrary household increases the probability of VSWM system formation in (3). Thus, (3) and (4) can be used to identify how a number of other variables affect the probability of such systems coming into being.¹¹

For example, if information costs are increasing in the number of households in the neighborhood or if coordinated action is simply more difficult as the number of actors increases, then the probability of VSWM system formation will be decreasing in the number of households in the neighborhood. On the other hand, a larger neighborhood implies a larger potential set of participants, so that a given threshold, n , may be easier to reach in larger neighborhoods. Education could increase the probability of cooperation if it increases the perceived benefits of environmental improvements. However, more-educated individuals may be more or less likely to cooperate for other reasons, depending on the nature of their education. Income may have little direct effect on the probability of cooperation, but it may proxy for other variables that can affect the costs and benefits of joining a VSWM system. At higher income levels, the actual cost of joining a VSWM system may represent a very small share of total expenditure suggesting that it would be easier for these households to join. However, we suspect that higher income neighborhoods have better municipal trash removal services due to greater influence with local politicians (a form of social capital not captured in our survey), so that the benefits from a VSWM system will be lower in these neighborhoods. Variables for each of these determinants of cooperation are included in the neighborhood probit below.

Given the general formulation of (3) and (4), it is not possible to determine the effect of social capital on the probability that a VSWM system will form. Without making strong distributional assumptions on $\Pr(r | N-1, k)$, it is impossible to sign unambiguously $\partial[\Pr(r | N-1, k)]/\partial k$ and therefore

¹¹ We model the probability of a neighborhood forming a VSWM system as a function of household level social capital and other household characteristics. However, we are unable to empirically estimate the household's decision to join a proposed VSWM system because the data do not include enough variation in household decisions within neighborhood samples defined by the presence of a VSWM system. In neighborhoods with community organized trash disposal groups in our sample nearly all respondents are members, while we do not observe the outcome of household decisions

to sign $\partial[\Pr(y_j = 1)]/\partial k$. However, the effect of individual and neighborhood social capital on the private costs and benefits of joining the VSWM system are more clear. As noted above, an increase in neighborhood social capital reduces the costs $c(k)$ of participating in collective activity. In addition, household social capital may increase the direct benefits $B(k_i, b_i)$ of participation if norms of reciprocity are strong. Both of these effects lower the expected net private costs of participation in (2), thereby increasing the probability that the household will join, $p_i(k_i)$. While the effect of an increase in social capital on the probabilities $\Pr(r | N - 1, k)$ depend critically on the distributional assumptions, our hypothesis is that the reduction in individual net costs of joining from increased social capital is a significant determinant of the probability of VSWM system formation.

4. Estimation strategy

We model the probability that a neighborhood in Dhaka will organize a VSWM system as a function of contemporaneous and predetermined measures of neighborhood social capital and other neighborhood-specific variables. Contemporaneous social capital is proxied by indicators of the level of trust and strength of norms of reciprocity and sharing. However, these measures of social capital are simultaneously determined with the establishment of a VSWM system since the process of developing a VSWM system can strengthen social networks, may encourage participation in other civic and social organizations, and can build trust and reinforce norms of reciprocity. In order to account for the joint determination of cooperation for creation of a VSWM system and social capital, we estimate a simultaneous equations system with both discrete and continuous endogenous variables using the two-stage conditional maximum likelihood (2SCML) estimation procedure developed by Rivers and Vuong (1988).

Our simultaneous equations model includes an equation, (5.a), for each of the three contemporaneous continuous measures of social capital plus a probit regression, (5.b), explaining the probability that the neighborhood has organized a VSWM system. The i th observation in the system is:

$$(5.a) \quad Y_i = y_i^* \cdot \alpha + X_{1i}' \Gamma + U_i \quad \text{where } i=1, \dots, n.$$

$$(5.b) \quad y_i^* = Y_i' \gamma + X_{2i}' \beta + u_i$$

Here, Y_i , representing social capital is a 3×1 vector, X_{1i} and X_{2i} are $p \times 1$ and $k \times 1$ vectors of exogenous variables, and α , Γ , γ , and β are 3×1 , $p \times 3$, 3×1 , and $k \times 1$ matrices of coefficients, respectively. The variable y_i^* represents latent strength of cooperation for community-organized trash disposal in the i th

on proposed VSWM systems in neighborhoods without them. Therefore, we focus only on neighborhood level outcomes in the estimation.

neighborhood. Although cooperation is unobserved, we observe whether or not a VSWM system exists, which we represent by the binary variable, y_i , defined as

$$y_i = 1 \text{ if } y_i^* > 0 \\ y_i = 0 \text{ otherwise.}$$

Equations (5.a) include three social capital regressions with observations on n neighborhoods. Neighborhood social capital is determined by the (endogenous) presence of a VSWM system, the professional and tenurial status of neighborhood residents, regional origin of residents, local infrastructure, and number of pre-existing civic organizations. Equation (5.b) is a probit regression of neighborhood cooperation for provision of the VSWM system public good with endogenous social capital. The degree of cooperation is conditioned on the three contemporaneous social capital variables, the number of households in the neighborhood, income and education levels, the ratio of homeowners to tenants, number of pre-existing civic organizations and the distribution of professions among neighborhood residents.

Maximum likelihood estimation of systems with discrete and continuous endogenous variables as in (5) is generally only feasible in systems of low order because of computational difficulties. As a result, two-stage estimation procedures are often used, such as those developed by Heckman (1978) and Amemiya (1978). Because the Dhaka sample consists of only 65 neighborhood observations, finding an efficient estimator of equations (5) is critical. We employ the 2SCML procedure of Rivers and Vuong (1988) because Monte Carlo results demonstrate that it outperforms the Heckman (1978) and Amemiya (1978) approaches in small samples. A demonstration of the relationship of the Rivers and Vuong (1988) estimator to the approaches of Heckman (1978) and Amemiya (1978) for generating consistent parameter estimates of (7) is provided in Note A.1 of Appendix A.

Following Rivers and Vuong (1988) we rewrite equation (5.b) in the form

$$(6) \quad y_i^* = Y_i' \gamma + X_{2i}' \beta + V_i' \lambda + \eta_i, \quad \text{where } \eta_i = u_i - V_i' \lambda.$$

Here, V_i is the 3×1 vector of residuals from the reduced form social capital regressions

$$(5.a') \quad Y_i = \Pi' X_i + V_i.^{12}$$

An appropriate normalization for this system is $\sigma_{uu} - \lambda' \Sigma_{vv} \lambda = 1$, where Σ_{vv} is the covariance matrix of residuals V_i . Estimation of the conditional ML probit regression then takes place in two steps. First, we estimate the reduced form social capital regressions to obtain $\hat{\Pi}$ and $\hat{\Sigma}_{vv}$, whose diagonal elements are

¹² The matrix X_i in the reduced form social capital equations has as columns all of the exogenous variables in system (5). It is related to the matrices of exogenous regressors in equations (5.a) and (5.b) by the identities $X_{1i} = J_1' X_i$ and $X_{2i} = J_2' X_i$, where J_1 and J_2 are the selection matrices of ones and zeros that retrieve X_{1i} and X_{2i} , respectively.

estimated by $\frac{1}{n} \sum_{i=1}^n \hat{V}_i \hat{V}_i'$ where $\hat{V}_i = Y_i - \hat{\Pi}' X_i$. Next, we estimate the probit regression for (6)

substituting \hat{V}_i for V_i to obtain $(\hat{\gamma}, \hat{\beta}, \hat{\lambda})$. Standard errors of parameter estimates are taken from the asymptotic covariance matrix for this estimator described in Rivers and Vuong (1988, p. 355).

An advantage of the Rivers and Vuong procedure is that it is possible to develop a simple Wald statistic from parameter estimates for λ to test for exogeneity of the social capital variables in the cooperation probit. The details of this hypothesis test are provided in Note A.2 of Appendix A.

In estimation of the social capital equations, (5.a), Hausman tests for exogeneity based on original least squares estimates do not allow us to reject (at 5% significance) the exogeneity of the existence of VSWM systems.¹³ However, the inverse power function test developed by Andrews (1989) indicates that the power of these Hausman tests for the exogeneity of VSWM system presence is quite low, probably because there are so few observations. Therefore, we re-estimate the social capital regressions treating VSWM system presence as endogenous, following Amemiya (1978).

Let the reduced form equation for cooperation for the creation of a VSWM system take the form

$$(5.b') \quad y_i^* = \tilde{\Pi}' X_i + \omega_i.$$

Amemiya (1978) shows that structural parameters (α_k, Γ_k) from the k th social capital equation in (5.a) can be recovered by the following regression (in matrix notation) of reduced form parameter estimates from equations (5.a') on reduced form parameter estimates from (5.b') and the selection matrix J_1 ,

$$(7) \quad \hat{\Pi}_k = \hat{\tilde{\Pi}} \alpha_k + J_1 \Gamma_k + \eta$$

where $\eta = (\hat{\Pi}_k - \Pi_k) - \alpha_k (\hat{\tilde{\Pi}} - \tilde{\Pi})$ and subscript k denotes the columns of $\hat{\Pi}$ and Γ and the row of α corresponding to the k th social capital regression.

Consistent estimation of the VSWM system probit requires another modification to account for the approach used to identify sample neighborhoods in Dhaka. As discussed in Section 5 below, neighborhoods were selected using *choice-based sampling* in which the population of neighborhoods was first stratified based on whether or not the neighborhood has a VSWM system. Then neighborhoods were randomly selected from within strata. This approach leads to biased parameter estimates in probit estimation without correction for sample selection. Manski and Lerman (1977) show that the inconsistency is removed if each observation's contribution to the likelihood function is given the following weight:

$$w(i) = \frac{Q(i)}{H(i)}, \quad \text{where } i = \begin{cases} 0, & \text{if the NH does not have a VSWM system.} \\ 1, & \text{otherwise,} \end{cases}$$

¹³ Results of reduced form estimation of the probit regression used to predict VSWM system presence for the Hausman tests of exogeneity are presented in Appendix B, Table B2.

and where $Q(i)$ is the fraction of the population with VSWM system indicator i and $H(i)$ is the fraction of the sample with VSWM system indicator i . This weighting scheme and the corresponding corrections to the asymptotic covariance matrix of the parameter estimates were used in estimation of equation (5.b). The sampling approach itself is discussed in detail in the following section.

5. Data collection

We undertook a survey of voluntary solid waste management practices in Dhaka between November 1997 and January 1998 using a structured questionnaire and interviewing households in sixty-five lower to upper middle-class neighborhoods of the city. The object of the survey was to collect household- and neighborhood-level information that would allow us to construct measures of associational activity, trust, reciprocity and sharing, as well as to learn about neighborhood characteristics that might explain the establishment of the VSWM systems that exist in some of these neighborhoods.

The survey was confined to the service area of the Dhaka City Corporation (DCC) in Dhaka City, which covers approximately 360 square kilometers. The sample is stratified on whether or not the neighbourhood has a VSWM system. This *choice based sampling* technique was adopted to ensure that the sample would contain “enough” neighborhoods with the relatively rare VSWM systems that our results would be reliable. A thorough search turned up 55 neighborhoods with VSWM systems in Dhaka. An additional 44 neighborhoods without VSWM systems were identified to comprise a population of 99 neighborhoods out of approximately 1058 neighborhoods in Dhaka. The neighborhoods identified were thought to be qualitatively representative of other middle-income neighborhoods in the city. From this subpopulation 35 neighborhoods were randomly drawn from the stratum of neighborhoods with VSWM systems and 30 neighborhoods were drawn from those without, creating a sample of 65 neighborhoods from which households were selected for interviews. Within each neighborhood, an average of ten households was chosen for interviews from among neighborhood residents.

The questionnaire had three modules. The first module dealt with information regarding the community such as the number of residents, their districts of origin, mix of homeowners and tenants, age of the neighborhood, etc. It also recorded the number of civic and sports associations, frequency of meetings, membership, etc. Questions in this module were asked of a knowledgeable neighborhood authority. The second module gathered information on the households that participated in the survey. Household heads were asked questions about the income/expenditure, education, age and profession of the members of the household, as well as questions regarding trust, reciprocity, and sharing, which formed the basis of our proxies for social capital. The final module, with information about the process of initiating the VSWM

systems, was asked of the VSWM system initiators in areas with functioning systems, in an attempt to understand the motivation of VSWM system initiators¹⁴ and the characteristics of the systems themselves.¹⁵

6. Data description and selection of variables

The data set covers sixty-five neighborhoods and 652 households, with ten households on average from each neighborhood. The basic unit of analysis is the neighborhood. Table 1 presents summary statistics of the variables used in our analysis and Table B1 in Appendix B presents Pearson correlation coefficients for all pairs of variables. Table 2 provides an illustrative snapshot of the difference in median levels of these variables in neighborhoods with and without VSWM systems.

The survey provided several measures of social capital. This allows us to test the applicability of the theories of Coleman and Putnam for public good provision as well as to identify the differential effects of various types of social capital on cooperation. Following Knack and Keefer (1997) and others, we use a measure of trust, plus two unique measures of norms of reciprocity and sharing (based on our questionnaire) as proxies for social capital. Our measures for trust, reciprocity, and sharing are based on the neighborhood mean of the categorical scores of the individual households for the following questions in the questionnaire:

Trust:

- 1) Would you hire someone based on your neighbors' recommendations?
- 2) In an emergency would you leave your young children with your neighbors?

Reciprocity:

- 1) Do you or your neighbors help arrange funerals for someone who dies in the neighborhood?
- 2) Do you or your neighbors send food to the family after a death in the family of your neighbors?
- 3) Do you or your neighbors help each other in taking sick neighbors to doctors or hospitals?

Sharing:

¹⁴ The two earliest VSWM systems in Dhaka were initiated by individuals who had been exposed to relatively more sanitary conditions than in Dhaka in the course of extended stays overseas. They were extremely motivated and put in large amounts of their own time and money in an effort to organize trash disposal in their neighborhoods and involve their neighbors in the effort. The development of many of the newer systems was inspired by these pioneers, who had received television publicity.

¹⁵ It is interesting to note that in the neighborhoods where VSWM systems exist, participant households are charged a fixed monthly fee, regardless of household size or quantity of trash discarded. This fee varies from \$0.20 to \$0.60 (with a median of \$0.30), with higher charges when the collected garbage needs to be removed from the neighborhood altogether. The initial investment required to start such a system appears to be low, varying between \$50.00 and \$600.00, with a median of \$280.00. The minimum scale required is roughly 250 households according to the initiators we interviewed. While initiators noted that many people were reluctant to pay for a service that is considered to be the city's responsibility, some VSWM systems have operated profitably. This suggests some scope for privatization of trash collection in the city, perhaps with tax breaks to neighborhoods that organize and finance their own trash collection.

- 1) Do you or your neighbors send each other cooked food or sweets during religious and social festivals or on any happy occasion?
- 2) Do you or your neighbors share fruits or vegetables grown on your own premises or at your village home?

Household responses of “Frequently”, “Occasionally”, or “Never” were recorded and converted into an increasing frequency index from 0 to 100 for each question. Household scores for trust, reciprocity and sharing are the average of the indices for the relevant questions. Neighborhood variables are the mean of the household scores for each neighborhood.

Table 1. Summary statistics and variable definitions

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Presence of VSWM system in neighborhood (dummy)	65	0.54	0.50	0.00	1.00
Average trust score in observed households	65	24.37	16.05	0.00	71.43
Average reciprocity score in observed households	65	73.13	11.40	50.00	95.00
Average sharing score in observed households	65	69.46	13.58	36.11	97.22
Number of sport, women’s orgs in neighborhood before VSWM	65	0.38	0.49	0.00	1.00
Number of religious, welfare, neighborhood-watch, library orgs in neighborhood before VSWM	65	0.75	0.77	0.00	3.00
Share of neighborhood residents that are homeowners (%)	65	25.64	6.35	16.00	40.00
Number of households in neighborhood	65	605.63	352.63	63.00	1500.00
Dummy for whether Chittagong is district of origin of largest group of households	65	0.57	0.50	0.00	1.00
Share of respondents working in business	65	23.03	11.30	0.00	50.00
Median education of adults in respondent households (years)	65	11.59	1.72	5.50	14.45
Median monthly per capita income of respondents (Taka)	65	3394.97	1283.13	1200.00	8267.86
Number of centers, clubs, fields, and meeting places in neighborhood	65	0.63	0.98	0.00	4.00
Median number of years respondents had lived in neighborhood	65	20.28	13.51	1.50	67.00

In addition, we develop measures of activity in civic and social associations, which Putnam argues can be an important source of social ties that build social capital. Information on associations and the existence of various community facilities was derived from the non-household interview part of the survey. We used two variables to proxy the associational depth of the community, both based on the number of

associations or organizations that had existed *prior* to the establishment of the VSWM system to ensure exogeneity with respect to the VSWM system. The first was the number of associations providing a “private” good or service, where we counted sports and women’s associations – whose services are typically available to association members only. The second was the number of organizations providing a “public” good or service, where we counted welfare associations, neighborhood watches, religious associations¹⁶, and library associations.¹⁷ These measures of associational activity act as predetermined explanatory variables in the VSWM system (cooperation) probit and in the social capital regressions.

Table 2. Comparison of medians across neighborhoods with and without VSWM systems in place

Variable	With VSWM	Without VSWM
Neighborhood trust	30.00	16.70
Neighborhood reciprocity	77.50	68.43
Neighborhood sharing	70.45	65.00
Pre-existing private civic assoc.	0	1
Pre-existing public civic assoc.	1	0.5
Proportion of residents who are homeowners	27.78	22.02
Number of households in neighborhood	650	502
Chittagong district dummy	1	0
Share of workers in business	20.00	26.82
Median education	12.00	11.22
Median per capita income	3166.67	3237.50
Number of meeting places	0	0
Median tenure of residents	15.50	24.25

Median education of adults and median per capita income were calculated on the basis of household information collected during the survey. Information on the number of households in the neighborhoods and the proportion of homeowners among residents was collected during interviews with initiators or knowledgeable persons from the community. As discussed in Section 3, the expected impact of neighborhood size, median education, and income on VSWM system development can be either positive or negative. We expect the proportion of homeowners to have a positive effect on the probability that the

¹⁶ Because virtually all residents of the neighborhoods are Muslim, very few are excluded from the mosques or the various social services provided by mosque committees. Use of the mosques is non-rival since attendance by others does not reduce an individual’s ability to participate.

¹⁷ These two variables are measured with some error since we measure the age of an organization as the earliest date at which one of our respondents joined. This means that we only know the approximate age of an organization if one of our respondents is a member. If the organization exists but no member of our sample belongs to it, we cannot count it since we do not know if it was created before the VSWM system. In addition, when there are multiple organizations of the same type (e.g., sports clubs) in a neighborhood the data do not allow us to distinguish between them and thus only

neighborhood organizes a VSWM system because homeowners are likely to be more permanent residents, suggesting that they will be more willing to invest in neighborhood quality. In addition, homeowners may want to protect their investment by supporting a trash disposal scheme since a cleaner neighborhood will have higher housing values. The share of neighborhood residents working in business¹⁸ was constructed based on the occupation of all adult (>21yrs) members of respondent households. Social ties play an important role in the Dhaka business community. These could have a significant effect on cooperation for trash disposal if the share of neighborhood residents working in business is high. The effect of the business community on the development of a VSWM system will be negative if the community tends to operate exclusively, as in the examples cited by Olson (1965). It will be positive if the community's social ties and experience foster problem solving.

The share of neighborhood residents working in business is also used to explain trust, reciprocity and sharing in the social capital regressions because of the importance of social networks to performance in the Dhaka business community. Median per capita income is also included as an explanatory variable in the social capital regressions because we expect that reciprocal social relationships insure individuals against risk and that higher income individuals have a lesser need to insure in this manner.

An important empirical issue in the 2SCML estimation is the availability of instruments to identify the social capital variables, distinct from cooperation for public good provision, and vice versa. We have identified three variables that we believe are closely associated with social capital and do not independently affect the probability of cooperation except through social capital. The first of these is the median tenure of residents in the neighborhood, measured by responses to the household portion of the questionnaire. As social relationships develop over time, norms of interaction develop as well and the potential for beneficial reciprocal arrangements to arise can increase. We believe that the effect that length of relationships between neighborhood residents has on their propensity to cooperate in public good provision operates almost exclusively through the development of social norms—social capital. We also believe that, after controlling for the horizontal ties that characterize civic associations (through the indicators for numbers of pre-existing private and public neighborhood associations), the three measures of social capital are defined broadly enough to capture most of the effect of tenure on cooperation through social capital.

The second variable to identify social capital is a measure of neighborhood infrastructure that facilitates social interaction: the number of community centers, clubs, fields and meeting places in the neighborhood. These facilities provide the location for the kind of casual social interaction that Putnam (1993, 1995) argues is vital to building strong social ties. We posit that it is through these interactions that neighborhood infrastructure bolsters cooperation.

the oldest is counted. This said, we think the errors are unlikely to lead to a serious undercount and we have proceeded to use these variables as measures of associational activity.

¹⁸ As opposed to occupations classified as professional, government or private service, or other.

Finally, our data includes the proportion of neighborhood residents that originate from different regions of Bangladesh. Individuals from the Chittagong district in Bangladesh are known to have strong social norms that favor sharing and reciprocity. Therefore, we include a dummy variable in the social capital regressions for whether the Chittagong district is the region with the highest share of resident origin.

The probability of cooperation for formation of a VSWM system is identified by the share of homeowners, the number of households in the neighborhood and median education levels, as discussed above. We could not think of a credible argument as to why these variables would directly foster social capital. For example, while the number of households in the neighborhood affects the probability of reaching a threshold number of VSWM system participants, respondents are likely to answer questions regarding trust and reciprocity between their neighbors in terms of those living nearby. As a result, the size of the neighborhood is not directly relevant.

Omitted Quality of Municipal Trash Disposal Services

We do not observe the quality of municipal trash disposal services before any VSWM systems were formed, which raises the concern that the neighborhoods that formed a VSWM system were simply those with low quality of municipal trash services. This omitted variable also biases our estimates of the role of social capital in VSWM system development. If this bias is large and positive, it calls into question the interpretation of our results if estimation identifies positive effects of social capital on VSWM system formation. We can eliminate both of these concerns.

Our survey data provide evidence that trash accumulation remains a major problem in neighborhoods without a VSWM system and that there is considerable interest in addressing the problem through local cooperation. Respondents to our survey were asked to rank the top three “major problems encountered by the neighborhood,” in 17 categories including irregular disposal of trash, inadequate clean water, irregular electricity supply, thuggery, thievery, noise pollution, deteriorating roads, and lack of sewers, among others. In neighborhoods with a VSWM system this variable provides an *ex post* indicator of the severity of the neighborhood trash problem. This precludes us from using this measure as an indicator of the quality of municipal neighborhood trash collection services in estimation. However, 51% of survey respondents from the 30 neighborhoods without a VSWM system listed regularity of trash disposal among the top three neighborhood problems, suggesting that it remains a serious problem in these neighborhoods. In the 35 neighborhoods with a VSWM system, only 12% of respondents listed trash collection among the top three problems. In addition, respondents were asked to rank the top three problems needing to be addressed through organized community action. Here, 67% of the respondents from neighborhoods without a VSWM system listed irregular trash collection among the top three problems and 45% ranked it as the highest priority for community action. There appears to be a high level of individual interest in solving the trash problem in these neighborhoods, but no community-organized trash disposal scheme has developed.

Next we determine whether the bias from omitted municipal trash collection services contributes to the effects of norms of reciprocity and sharing found below. Consider the regression for the probability that a neighborhood organizes a VSWM system if the quality of municipal trash collection services, Q_i , were observed:

$$(8) \quad y_i^* = Y_i' \gamma + X_{2i}' \beta + Q_i \delta + u_i, \quad i = 1, \dots, n$$

$$y_i = 1 \quad \text{if } y_i^* > 0$$

$$y_i = 0 \quad \text{otherwise.}$$

Following the results of Yatchew and Griliches (1985) concerning specification errors in the probit model, if Q_i given Y_i and X_i is normally distributed, the probit estimator for the j th social capital variable, $\hat{\gamma}_j$, will converge asymptotically to

$$(9) \quad \frac{\gamma_j + \delta \alpha_j}{\sqrt{\delta^2 \sigma_\varepsilon^2 + \sigma_u^2}},$$

where α_j is the coefficient of the j th social capital variable in a least squares regression of Q_i on social capital, Y_i , and all other regressors from (8), X_{2i} , and where σ_ε^2 is the variance of the error term from this regression. The second term in the numerator of (9) is identical to the effect of bias from an omitted variable in least squares. The difference in the probit case is the assumption regarding the conditional distribution of Q_i and the scale factor in the denominator.¹⁹ Since the denominator must be positive, the sign of the bias is given by $\text{sign}(\delta) \cdot \text{sign}(\alpha_j)$. The first component of this bias is negative, since better municipal services reduce the probability of neighborhood residents organizing a VSWM system. We argue that the effect of social capital on the quality of municipal trash collection services is positive since stronger norms of reciprocity and sharing will improve the quality of neighborhood lobbying efforts for more regular municipal trash pick-up. Therefore, the overall effect of omitted municipal trash collection services is a downward bias in the social capital coefficients, so that the marginal effects presented below represent a lower bound on the true effect of social capital on the probability of VSWM formation.

¹⁹ Yatchew and Griliches (1985) derive an implicit expression for the bias if the distribution of Q_i given Y_i and X_i is not normal. In this case, (9) serves as an approximation to the bias, the accuracy of which depends on the third and higher order moments of the conditional distribution of Q_i .

7. Results

(i) Social capital

Parameter estimates of the social capital regressions are presented in Table 3. The measures of trust, reciprocity and sharing served as the dependent variables in these regressions. Explanatory variables in each social capital regression include cooperation for creation of a VSWM system²⁰, the number of pre-existing private-good- and public-good-oriented civic associations, median tenure of residents in the neighborhood, predominance of residents from Chittagong, share of residents that are homeowners, share of business among neighborhood occupations, and the number of community social facilities. Determinants of social capital were estimated first by least squares (Columns 1-3) since preliminary Hausman tests failed to reject the exogeneity of the presence of a VSWM system in each of the three regressions.²¹

Because the low number of neighborhood observations in our sample weakens the precision of parameter estimates, we use the inverse power function (Andrews 1989) to interpret the failure of the Hausman test to reject exogeneity.²² Results show that the power of our Hausman tests is very weak in this setting; the probability of type II error is greater than 50%, so we conclude that our Hausman tests are uninformative. To avoid biased parameter estimates, we re-estimate equations (5.a) assuming the VSWM system dummy is endogenous and treating the endogeneity using the 2SLS approach of Amemiya (1978). These results are presented in Columns 4-6 of Table 3.

The strength of cooperation for development of a VSWM system contributes significantly to the creation of all three measures of social capital in both OLS and modified 2SLS estimation. In each case, the parameter estimates fall using the 2SLS approach, as would be expected were VSWM system presence simultaneously determined with social capital. The significance of the trash schemes is somewhat surprising given that in most cases they only started operation less than three years before the survey. Nonetheless, the process of developing community-organized trash removal fosters stronger social ties. This suggests a qualified, though mostly benign, role for policy. By eliminating barriers to cooperation for public good provision, and perhaps through limited incentives (such as tax rebates), the government may encourage community activity, and the resultant strengthening of social networks may have a variety of benefits.

Table 3. Determinants of Social Capital

²⁰ In the OLS regressions, latent cooperation for creation of a VSWM system is proxied by the dummy variable for VSWM system presence. In the 2SLS regressions, a consistent estimate of the structural parameter on latent cooperation is recovered by regressing reduced form parameters from the appropriate social capital regression in (5.a') on the reduced form parameters from (5.b') and the selection matrix J_1 . This method of recovering the parameter estimate for the latent endogenous variable is the heart of Amemiya's approach.

²¹ T-statistics for the exogeneity tests are presented in the last row of Table 3.

²² The results of the inverse power function tests are presented in Note A.3 of Appendix A.

Dependent Variable	NH Trust OLS	NH Reciprocity OLS	NH Sharing OLS	NH Trust 2SLS	NH Reciprocity 2SLS	NH Sharing 2SLS
Intercept	11.9247 (8.2502)	52.7270** (5.9775)	46.0349** (6.9728)	17.7075** (8.2170)	56.3214** (5.8210)	51.9712** (6.5050)
Cooperation for creation of VSWM System	8.2260* (4.1449)	5.5647* (3.0031)	7.3821** (3.5032)	4.1002** (1.9260)	2.2244* (1.3110)	4.7258** (1.5530)
Number of meeting places	-6.8949** (1.9171)	3.5244** (1.3890)	0.5670 (1.6202)	-8.5277** (2.1940)	2.7408* (1.5410)	-1.5457 (1.7430)
Median tenure of respondents	0.2691* (0.1456)	0.2358** (0.1055)	0.2080* (0.1231)	0.3852** (0.1652)	0.2927** (0.1154)	0.3569** (0.1317)
Chittagong district plurality	6.6374 (4.4832)	8.2975** (3.2482)	12.8974** (3.7890)	2.2784 (5.3630)	6.3418 (3.8280)	7.0234 (4.2310)
Share of workers in business	0.3411* (0.1867)	0.3210** (0.1353)	0.4897** (0.1578)	0.3298* (0.1894)	0.3146** (0.1334)	0.4742** (0.1503)
Median per capita income	-0.0021 (0.0014)	-0.0001 (0.0010)	-0.0011 (0.0012)	-0.0025* (0.0015)	-0.0003 (0.0010)	-0.0016 (0.0012)
Pre-existing private civic associations	2.9501 (4.1644)	0.1043 (3.0172)	2.2266 (3.5196)	6.5404 (4.7910)	1.7626 (3.4080)	7.0072* (3.7860)
Pre-existing public civic associations	1.5374 (2.4777)	-1.9891 (1.7952)	-1.0294 (2.0941)	0.0474 (2.6490)	-2.6928 (1.8910)	-2.9991 (2.0900)
Adj. R ²	0.2525	0.2223	0.2541	0.2979	0.2847	0.4019
N	65	65	65	65	65	65
T-stat for exogeneity test	1.147	0.468	1.186			

Standard errors in parenthesis.²³

* Significant at 10%

** Significant at 5%

Both the share of adults working in business and the tenure of neighborhood residents are positively and significantly associated with all three measures of social capital. The strong effect of the business community verifies the important role of social ties in business in Dhaka. It is not possible to determine whether this effect is derived from the strength of social networks *within* the business community or whether members of the business community foster greater trust and norms of reciprocity in their relationships with *other* community members, including those not involved in business.

Neighborhoods with a majority of residents originating from Chittagong district demonstrate stronger norms of reciprocity and sharing in the least squares regressions as their reputation suggests. However, this effect is removed in the two-stage estimation procedure with endogenous cooperation for trash removal. Surprisingly, the number of community social facilities and meeting places builds norms of reciprocity, but is also negatively associated with trust. It is unlikely that this variable is a proxy for the level of development, since these regressions control for income. It appears that the types of activities that

take place in these facilities encourage reciprocal exchanges, and that trust most probably arises from deeper relationships and interactions.

Per capita income demonstrates only a weak negative effect on the level of trust among neighborhood residents in the 2SLS results. Earlier, we posited a negative role for income, but primarily regarding reciprocity which acts as a form of insurance. The negative coefficient on trust must be interpreted with some care, since very low and very high income neighborhoods were not included in our sample because neither is likely to have a VSWM system. Still, among middle income neighborhoods, an increase in income appears to be associated with declines in trust among respondents.

It is interesting to note that participation in civic associations is not associated, in general, with increased trust or stronger norms of reciprocity and sharing. The only exception is some effect of privately oriented clubs (sports and women's associations) in encouraging sharing of resources. To the uninitiated the weak results for civic associations appear to offer a rejection of Putnam's hypothesis that the kind of social ties developed in such associations is an important contributor to social capital. However, it is likely that formal membership in groups, which has been demonstrated to be a significant determinant of social capital in Putnam's studies of the US and Italy, is not as important as other, more casual, forms of associational activity in Dhaka.

(ii) Existence of a VSWM system

The results of the estimation of the 2SCML regression for the formation of a VSWM system in the neighborhood are presented in Table 4. We estimate this probit using each of the three contemporaneous measures of social capital as regressors in separate equations and then estimate the probit again including all three measures in the same regression. The marginal effects of the regressors on the probability that a neighborhood will develop a VSWM system are presented in Table 5. The reduced form regressions used to generate the \hat{V}_i terms are presented in Appendix Table B3.

The 2SCML estimates presented in Table 4 were obtained using the Rivers and Vuong (1988) approach to consistent estimation of the probit with simultaneously determined regressors, modified by the Manski and Lerman (1977) correction for choice-based samples.²⁴ The Wald statistic (Rivers and Vuong

²³ The standard errors presented for the 2SLS regressions in Table 3 are those resulting from the variance-covariance matrix derived by Amemiya (1978), with the modification that the covariance of residuals from reduced form regressions for social capital and cooperation was calculated using the method described by Heckman (1978).

²⁴ The 99 neighborhoods identified before sampling represent the population that is relevant for analysis. Fifty-five of these have a VSWM system. Using the choice based sampling approach, samples were drawn independently from within the strata defined by presence of a VSWM. Thirty-five neighborhoods with a VSWM system were drawn and 30 neighborhoods were drawn without a VSWM system, for a sample of 65 neighborhoods. In the sample correction procedure, the contribution of each neighborhood to the likelihood function is weighted by the ratio of the population fraction to the sample fraction that have (do not have) a VSWM system for neighborhoods with (without) such a scheme.

(1988)) used to test for the exogeneity of social capital variables in the cooperation regression rejects exogeneity in each case, implying that the use of the 2SCML technique to obtain consistent parameter estimates is justified. The estimation results show that the largest and most significant effect from a single social capital variable on the probability that a VSWM system will be formed is due to the strength of norms of reciprocity.

The marginal effects in Table 5 show that a 1% increase in the reciprocity index leads to a 2.8% increase in the probability that a VSWM system will form. Social capital indeed appears to have a major effect on cooperation for public good provision. The fact that of the three measures of social capital reciprocity has the greatest impact is consistent with the idea that reciprocity best represents the relationship underlying the phenomenon of organizing for SWM in the neighborhood.

Norms of sharing also have a significant positive effect on the probability of a VSWM system being formed. The effect of the sharing variable is nearly as large as that of reciprocity with a 1% increase in the index of sharing norms leading to a 2.1% increase in the probability that a VSWM system will form.²⁵ Trust on the other hand is not an important determinant of VSWM system formation. The marginal effect of trust is -0.0005, but the parameter estimate for trust in the 2SCML estimation is not significant. We conjecture that the relatively low stakes involved, and the transactional nature of coordinated action for solid waste disposal may mean that trust between neighbors is not particularly important for setting up such systems. Once created, the VSWM are relatively inexpensive to maintain with average monthly costs of 30 cents per household, so trust that other founding members will not later renege on their commitment is not a significant determinant of initial cooperation. Commonality of interests, as captured by reciprocity, may well be all that is required.

When the social capital variables are included together as regressors, the strength of the effect of social capital on the probability that a VSWM system exists disappears. This may be due to multicollinearity among these measures. Indeed, the correlation between reciprocity and sharing is 0.62, that between reciprocity and trust is 0.37 and that for trust and sharing is 0.44.

As a result of the sampling procedure used, neighborhoods with a VSWM system received a slightly higher weight in the estimation than those without. (The weights for neighborhoods with and without a VSWM system were 1.0317 and 0.9630, respectively). Thus, while the parameter estimates presented in Table 4 are purged of sample selection bias, neighborhoods with VSWM systems are overrepresented in our analysis.

²⁵ Keep in mind that the strong effects of norms of reciprocity and sharing on the probability of public good provision found here represent a lower bound on these effects because of the downward bias introduced by omitted quality of municipal trash collection services. The true effects of social capital on public good provision in this case are *at least* as large as presented here.

Table 4. Two-Stage Conditional Maximum Likelihood Estimates for Presence of VSWM System

Independent variables	Model I	Model II	Model III	Model IV
Neighborhood Trust	-0.0020 (0.0247)			-0.1329 (0.1530)
Neighborhood Reciprocity		0.1278** (0.0476)		-0.1104 (0.3649)
Neighborhood Sharing			0.0895** (0.0349)	0.2839 (0.3687)
Intercept	-6.8459** (2.5145)	-16.2107** (4.6220)	-9.4790** (3.1125)	-12.1357 (12.5163)
Share of hownowners	0.0683* (0.0407)	0.0148 (0.0506)	-0.0108 (0.0505)	-0.0181 (0.1201)
Number of HH in Neighborhood	0.0003 (0.0006)	-0.0002 (0.0008)	0.0004 (0.0007)	0.0013 (0.0027)
Median education	0.5399** (0.1875)	0.7784** (0.2466)	0.4584** (0.2089)	0.5404 (0.6338)
Share of workers in business	0.0033 (0.0209)	-0.0265 (0.0251)	-0.0328 (0.0252)	-0.0455 (0.0614)
Median per capita income	-0.0003 (0.0002)	-0.0004 (0.0003)	-0.0002 (0.0002)	-0.0003 (0.0005)
Pre-existing private civic associations	-0.9411** (0.4312)	-1.6472** (0.5995)	-1.5939** (0.5850)	-2.2634* (1.2801)
Pre-existing public civic associations	0.4949 (0.2969)	0.7958** (0.3725)	0.5737 (0.3493)	0.8245 (0.8905)
\hat{V}_{TRUST}	0.0200 (0.0289)			0.1454 (0.1528)
\hat{V}_{RECIP}		-0.0806 (0.0503)		0.1376 (0.3687)
\hat{V}_{SHARE}			-0.0606 (0.0382)	-0.2583 (0.3698)
N	65	65	65	65
Modified Wald stat. for exogeneity of social capital	31.81	191.44	184.00	309.03

Standard errors in parenthesis.²⁶

* Significant at 10%

** Significant at 5%

The median level of average household education in the neighborhood is also strongly related to the likelihood of a VSWM system coming into being in Models I-III. This suggests that education plays a role in raising awareness about the benefits of cleaner surroundings or about the indirect benefits from this type

²⁶ Standard errors are taken from the formulation of the variance-covariance matrix for 2SCML estimator in Rivers and Vuong (1988), modified by the weights used to correct for bias from choice based sampling.

of cooperation. Median per capita income is not significantly associated with the existence of VSWM systems at standard significance levels.²⁷

Table 5: Average Marginal Effects on Probability that Neighborhood Develops a VSWM System

Independent variables	Model I	Model II	Model III	Model IV
Neighborhood Trust	-0.0005			-0.0265
Neighborhood Reciprocity		0.0277		-0.0220
Neighborhood Sharing			0.0210	0.0566
Intercept	-1.8437	-3.5167	-2.2197	-2.4188
Share of homeowners	0.0184	0.0032	-0.0025	-0.0036
Number of households in Neighborhood	0.0001	-0.0001	0.0001	0.0003
Median education	0.1454	0.1689	0.1074	0.1077
Share of workers in business	0.0009	-0.0057	-0.0077	-0.0091
Median per capita income	-0.0001	-0.0001	-0.0001	-0.0001
Pre-existing private civic associations	-0.2535	-0.3573	-0.3732	-0.4511
Pre-existing public civic associations	0.1333	0.1726	0.1344	0.1643

The share of neighborhood residents that own their home has a significant effect on cooperation only in Model II. This result provides some evidence for the argument that homeowners are more likely to make investments in their neighborhoods. There are no significant effects of neighborhood size on the probability that a VSWM system will form, suggesting that strong coordination advantages are not available to smaller neighborhoods; nor are there benefits to having a larger pool of potential participants to choose from. Or perhaps these two effects are offsetting, making it difficult to identify the relationship between neighborhood size and the prospects for coordinated action for public good provision. The share of adults in respondent households working in business is also not a significant determinant of VSWM system formation. Although a large population of residents with a business occupation was shown to contribute to social capital above, occupation appears to have no independent effect on the organization of SWM systems.

Most intriguing was the strong negative effect of the number of private-good-oriented organizations on the existence of VSWM systems, while the effect of the number of public-good-oriented associations is positive and significant only in Model II. This may imply a sort of displacement or crowding out effect whereby the orientation of the “private” group militates against more publicly oriented activity. It is worth repeating that these variables count the number of groups or associations that existed *prior* to the

²⁷ However, because the sign on income is negative in all four regressions and income is marginally significant in regressions using only trust or reciprocity as social capital (with p-values of 11.7% and 10.6%, respectively), there is some evidence of a negative effect of neighborhood income on VSWM system formation for this population of middle-income neighborhoods, possibly reflecting better municipal service quality in higher income neighborhoods.

formation of a VSWM system, and are therefore predetermined. Clearly it isn't only that associational activity matters, but also that the type of associational activity is important.

8. Conclusions

This paper has presented the results of a micro-empirical survey-based study of households in 65 neighborhoods of Dhaka. Our results indicate that the organization of VSWM systems is a function of our proxy for social capital and of measures of associational activity, as well as the nature of such activity. Our results show that the different proxies we have used for social capital – trust, reciprocity and sharing – do, indeed, capture different aspects of social capital, with quite different impacts on community outcomes. Reciprocity among neighbors is far more important when it comes to cooperating for solid waste management than trust, for instance.

A clear policy implication of the analysis is that investments in education are likely to have spillover effects in terms of the ability to organize for SWM. However, we cannot say whether or not the promotion of associational activity (as has been mooted by proponents of the role of social capital in development following Putnam) has a positive net impact on the provision of a public good or service by a neighborhood committee – either directly or through higher social capital. We need also to remember the insight of Beall's (1997) case studies, that the nature of the good or service, and the circumstances of its underprovision are critical in determining the utility of greater associational activity.

The different aspects of social capital also appear to be enhanced by the formation of a VSWM system. The implication of this result for policy is not easy to decipher. Because the process by which community residents agree to cooperate for provision of trash removal is a function of the strength of their relationships, it is unlikely that any direct attempt by government to initiate this process will be successful in boosting social capital. However, given that the presence of a VSWM system has a significant independent effect on social capital development, even after controlling for past participation in civic associations, limited policies that encourage community participation in public good provision by lowering information and transaction costs may contribute to a virtuous cycle of successful cooperation and strengthening social ties.

The most important policy implication of our work is that the introduction of public-private partnerships or self-help schemes is more likely to be successful in neighborhoods which are high in social capital. Thus social capital proxies or determinants can be used as predictors of success when targeting neighborhoods for different social or public-good-oriented interventions.

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Appendix A. Notes on estimation

(A.1) It is worth considering the comparability of the Rivers and Vuong (1988) estimator for the simultaneous equations probit in (5.b) to the Heckman (1978) and Amemiya (1978) estimators. The comparison provides an intuitive understanding of why the Rivers and Vuong estimator yields consistent parameter estimates of γ and β .

First, after adding the term V_i (estimated by \hat{V}_i) to (5.b) as in (6), if $\gamma + \lambda = 0$ and $\lambda \neq 0$ (6) becomes

$$(6.a) \quad y_i^* = X'_{2i}\beta + X'_i\hat{\Pi}\lambda + \eta_i.$$

This is identical to the instrumental variables approach to estimation of a discrete choice simultaneous equations system of Heckman (1978) in which Y_i ($m \times 1$) is replaced by its predicted value. However, dropping these restrictions, we can rewrite (6) as

$$(6.b) \quad y_i^* = Y'_i\mu + X'_i v + \eta_i,$$

where $\mu = \gamma + \lambda$ and $v = J_2\beta - \hat{\Pi}\lambda$. In matrix notation,

$$y^* = Y\mu + Xv + \eta,$$

where y^* is an $n \times 1$ vector, Y and X are $n \times m$ and $n \times p$ matrices, respectively, and the parameters μ and v are just as before. Premultiplying by $(X'X)^{-1}X'$,

$$(6.c) \quad (X'X)^{-1}X'y^* = (X'X)^{-1}X'Y\mu + v + \eta.$$

GLS estimation of (6.c) will recover consistent estimates of μ and v . Let $y^* = \tilde{\Pi}'X + \omega$ be the reduced form cooperation regression. Then, substituting for reduced form parameter estimates and v , we have

$$\hat{\tilde{\Pi}} = \hat{\Pi}\mu + J_2\beta - \hat{\Pi}\lambda + \eta,$$

which can be simplified as

$$(6.d) \quad \hat{\tilde{\Pi}} = \hat{\Pi}\gamma + J_2\beta + \eta.$$

This is identical to the equation used by Amemiya to recover consistent estimates of the structural parameters from reduced form parameter estimates for the discrete choice simultaneous equations system.

Amemiya's approach involved GLS estimation of (6.d) where $\eta = \left(\hat{\tilde{\Pi}} - \tilde{\Pi} \right) - \gamma \left(\hat{\Pi} - \Pi \right)$. Amemiya's estimator in (6.d) is identical to the Rivers and Vuong estimator in (6), transformed by premultiplication by $(X'X)^{-1}X'$.

(A.2) One of the benefits of the 2SCML method for estimating the cooperation equation (5.b) is that it

provides a simple method for testing exogeneity of the social capital variables in this equation. Substituting for V_i in equation (6) and gathering terms,

$$y_i^* = Y_i'\mu + X_i'\beta + X_i'\hat{\Pi}\lambda + \eta_i,$$

where $\mu = \gamma + \lambda$. This is the form of regression typically used to perform a Hausman test for exogeneity of regressors in which the potentially endogenous variables are included along with their predicted values. A test of the null hypothesis of exogeneity is equivalent to testing whether $\lambda = 0$. Rivers and Vuong (1988) show that, under the null hypothesis of exogeneity, the modified Wald statistic given by

$$MW = n\hat{\lambda}'\hat{V}(\hat{\lambda})^{-1}\hat{\lambda}$$

has an asymptotic central chi-square distribution with degrees of freedom equal to the number of variables in Y_i .

(A.3) We used Andrews' (1989) inverse power function to investigate the power properties of the Hausman test for exogeneity of VSWM system presence in the social capital regressions. The test of the null hypothesis of exogeneity is the test $H_0 : \theta = 0$ versus $H_1 : \theta \neq 0$, where θ is the parameter estimate for the predicted presence of a VSWM system in a regression of a single social capital equation from (5.a) that includes the VSWM system dummy and predicted VSWM system presence as right-hand-side variables. Andrews defines a region of high probability of type II error as $\{\theta : 0 < |\theta| \leq b\}$. Here, $b = \lambda_{1,\alpha}(1/2)\hat{\sigma}_\theta$ where $\lambda_{1,\alpha}(1/2)$ is the test statistic for the inverse power function for one parameter restriction at significance level α and $p=1/2$ and $\hat{\sigma}_\theta$ is a consistent standard error estimate for $\hat{\theta}$. If the exogeneity test fails to reject the null, no conclusions can be drawn about parameter estimates in this region since the probability of failing to reject the null hypothesis is greater than the probability of rejecting it for parameter values in this region.

Table A.1 presents the parameter estimates and standard errors for predicted VSWM system formation in the social capital regressions, as well as the corresponding measures of b evaluated at $\alpha=.05$. We find that the estimate of predicted VSWM formation lies within the critical region for each of the three social capital regressions, suggesting that the probability of type II error in the Hausman tests is high. As a result, we present two-stage estimates of the social capital regressions in Columns 4-6 of Table 3 assuming VSWM system formation is endogenous and correcting for the bias.

**Table A.1 Inverse Power Function Test for Region of High
Probability of Type II Error in Hausman Tests**

	$\theta_{\hat{y}_i}$	$\hat{\sigma}_{\theta}$	$\lambda_{1,0.5}(1/2)$	b
Neighborhood Trust	10.650	9.282	1.960	18.193
Neighborhood Reciprocity	3.176	6.791	1.960	13.310
Neighborhood Sharing	9.293	7.838	1.960	15.362

Appendix B.

Table B1. Matrix of Pearson correlation coefficients

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Presence of VSWM system	1.00													
2. Neighborhood trust	0.21	1.00												
3. Neighborhood reciprocity	0.23	0.37	1.00											
4. Neighborhood sharing	0.30	0.44	0.62	1.00										
5. Past private civic assoc.	-0.28	0.00	0.11	0.09	1.00									
6. Past public civic assoc.	0.11	0.21	0.06	0.16	0.21	1.00								
7. Share of homeowners	0.29	0.25	0.22	0.39	-0.27	0.15	1.00							
8. Number HHs in neighborhood	0.05	0.01	0.08	-0.04	0.22	0.23	-0.28	1.00						
9. Chittagong district dummy	0.44	0.22	0.17	0.33	-0.14	0.09	0.17	-0.09	1.00					
10. Share of workers in business	-0.26	0.13	0.17	0.18	0.27	0.20	-0.18	0.09	-0.48	1.00				
11. Median education	0.31	-0.01	-0.09	-0.01	0.03	-0.24	-0.10	0.29	0.24	-0.38	1.00			
12. Median per capita income	-0.12	-0.15	-0.03	-0.13	0.16	-0.15	-0.31	0.34	-0.12	0.06	0.46	1.00		
13. Number of meeting places	0.03	-0.35	0.31	0.06	0.27	0.08	-0.03	0.13	-0.17	0.10	-0.16	-0.06	1.00	
14. Median tenure of residents	-0.30	0.12	0.22	0.12	0.32	0.17	0.04	0.02	-0.30	0.30	-0.39	0.10	0.15	1.00

Table B2. First-stage probit to predict EXIST

Dep. Var.: Presence of VSWM Sytem*	Estimate	Standard Error	Wald Chi-Square	Prob
Intercept	-10.3533	3.2219	10.3259	0.0013
Share of residents that are homeowners	0.0800	0.042	3.6376	0.0565
Number of households in neighborhood	0.000336	0.000699	0.2311	0.6307
Median education of adults in respondent households	0.6488	0.2297	7.9790	0.0047
Number of centers, clubs, fields, and meeting places in neighborhood	0.6492	0.2926	4.9224	0.0265
Median number of years respondents lived in neighborhood	-0.0157	0.023	0.4693	0.4933
Dummy for whether Chittagong is district with highest share	1.6109	0.5648	8.1339	0.0043
Share of respondents working in business	0.0376	0.0259	2.1160	0.1458
Median monthly per capita income of respondents (in Taka)	-0.00023	0.000232	0.9576	0.3278
Past private civic associations	-1.6056	0.6103	6.9218	0.0085
Past public civic associations	0.5346	0.3444	2.4093	0.1206

*N=65.

Table B3: First-Stage Reduced Form Regressions

	Dep Var: Trust				Dep Var: Reciprocity				Dep Var: Sharing			
	R2:				R2:				R2:			
	adjR2:				adjR2:				adjR2:			
Variable	Estim	StdErr	tstat	Prob	Estim	StdErr	Tstat	Prob	Estim	StdErr	tstat	Prob
Intercept	-22.1479	19.8781	-1.114	0.2701	36.4275	14.3210	2.544	0.0139	4.1457	15.5669	0.266	0.7910
Share of homeowners	0.5599	0.3200	1.750	0.0858	0.5155	0.2305	2.236	0.0295	0.8893	0.2506	3.549	0.0008
Number of households	0.0053	0.0060	0.886	0.3793	0.0053	0.0043	1.232	0.2231	0.0017	0.0047	0.355	0.7242
Median education	1.7404	1.5337	1.135	0.2615	0.1835	1.1050	0.166	0.8687	1.6175	1.2011	1.347	0.1837
Number meeting places	-6.1693	1.9173	-3.218	0.0022	3.7893	1.3813	2.743	0.0082	1.2988	1.5015	0.865	0.3909
Median tenure	0.2718	0.1629	1.669	0.1010	0.1849	0.1174	1.576	0.1209	0.1681	0.1276	1.318	0.1931
Chittagong plurality	9.1043	4.2515	2.141	0.0368	10.1604	3.0629	3.317	0.0016	14.4872	3.3294	4.351	0.0001
Share workers in business	0.4666	0.1988	2.347	0.0226	0.3747	0.1433	2.616	0.0115	0.6327	0.1557	4.063	0.0002
Median per cap. Income	-0.0030	0.0018	-1.691	0.0966	-0.0001	0.0013	-0.065	0.9484	-0.0012	0.0014	-0.869	0.3886
Past private civic assoc.	1.1347	4.3309	0.262	0.7943	-0.0635	3.1202	-0.020	0.9838	2.2003	3.3916	0.649	0.5193
Past public civic assoc.	1.2347	2.6855	0.460	0.6475	-2.8008	1.9348	-1.448	0.1535	-1.3946	2.1031	-0.663	0.5101

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